

LIQUID CRYSTAL DISPLAY DECODER-DRIVER

- 5201 and 5202 Drive Dynamic Scattering Displays
- 5201-2 and 5202-2 Drive Field Effect Displays
- Advanced Silicon Gate Ion Implanted CMOS Technology
- 5201 and 5201-2 Display Hours, Minutes and Seconds on Command
- 5202 and 5202-2 Display Hours and Minutes
- Inputs Protected Against Static Discharge

The 5201, 5201-2, 5202, and 5202-2 are low power $3\frac{1}{2}$ digit liquid crystal display decoder/drivers intended for use in electronic timekeeping applications such as wristwatches and battery-operated clocks. The 5201 and 5202 are specified for operation over the supply voltage range 10 to 15 volts for use with dynamic scattering liquid crystal displays. The 5201-2 and 5202-2 are specified for operation from 6 to 10 volt supply voltages for use with field effect liquid crystal displays.

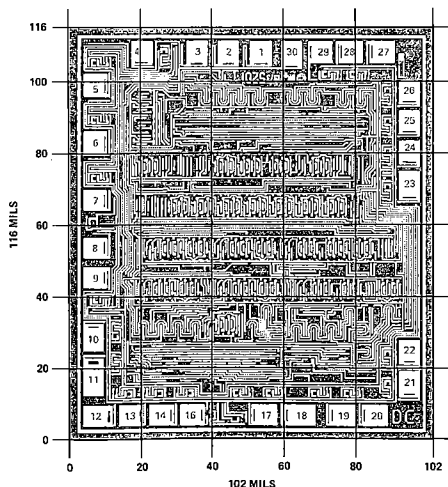
The 5201 and 5201-2 normally display hours and minutes. On activation of the seconds command switch, seconds are displayed in the minutes position and hours are blanked. Resetting of the seconds command switch restores the display mode to hours and minutes. The 5202 and 5202-2 display hours and minutes only. The colon is flashed at a 1 Hz rate on all four devices.

These decoder/drivers accept a 64Hz input signal from which they count and decode hours and minutes (and seconds in the case of the 5201 and 5201-2). The decoded signals are used for driving the three 7-segment and one 2-segment display digits. A symmetrical 32Hz signal is provided to drive the common back plate of the display. Segments to be energized are driven with a symmetrical 32Hz signal that is out-of-phase with the common signal while unenergized segments are driven with a symmetrical 32Hz signal in phase with the common signal.

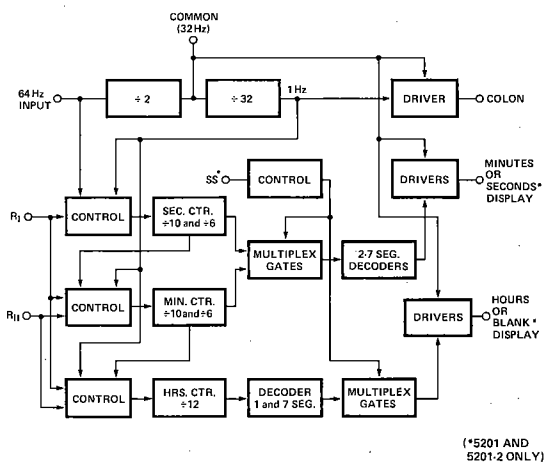
Two inputs allow for time setting and resetting. (See page 8-5 for description of operation.)

These devices are fabricated with complementary MOS silicon gate technology. This extremely low power technology is ideally suited for the manufacture of devices designed to operate from small batteries for long periods of time.

CHIP TOPOGRAPHY
(Numbers refer to package pin number.)



BLOCK DIAGRAM



Absolute Maximum Ratings*

Temperature Under Bias	.....	-20°C to +70°C
Storage Temperature	.....	-40°C to +125°C
Supply Voltage V_{DD} with respect to GND	.....	-0.3V to +18.0V
Voltage on all Inputs or Outputs with respect to GND	.....	-0.3V to V_{DD} +0.3V
Power Dissipation	.....	100mW

*COMMENT:

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

D.C. and Operating Characteristics for 5201 and 5202

Dynamic Scattering Liquid Crystal Display Applications ($T_A = 25^\circ\text{C}$; $10\text{V} \leq V_{DD} \leq 15\text{V}$; $f_{IN} = 64\text{Hz}$ unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$I_{DD}(\text{Avg.})$	Average Operating Current			500	nA	$V_{DD} = 15\text{V}$; $t_{pwc} = 25\mu\text{s}$; $t_f = 0.5\mu\text{s}$; $t_r = 35\mu\text{s}$; outputs open
$I_{DD}(\text{Static})$	Static Current			300	nA	$V_{DD} = 15\text{V}$; 64 Hz input open; outputs open
I_{IL}	Input Low Current	-5	-13	-28	μA	$V_{DD} = 15\text{V}$; $V_{IN} = 1.2\text{V}$
V_{IL}	Input Low Voltage	-0.3		1.2	V	$V_{DD} = 15\text{V}$
V_{IH}	Input High Voltage	14.0		15.3	V	$V_{DD} = 15\text{V}$
V_{OLC}	Output Low Voltage Common			0.1 0.1	V V	$V_{DD} = 15\text{V}$; $I_{OLC} = 1.5\mu\text{A}$ $V_{DD} = 10\text{V}$; $I_{OLC} = 1.0\mu\text{A}$
V_{OHC}	Output High Voltage Common	14.9 9.9			V V	$V_{DD} = 15\text{V}$; $I_{OHC} = -1.5\mu\text{A}$ $V_{DD} = 10\text{V}$; $I_{OHC} = -1.0\mu\text{A}$
V_{OLS}	Output Low Voltage Segments			0.1 0.1	V V	$V_{DD} = 15\text{V}$; $I_{OLS} = 0.1\mu\text{A}$ $V_{DD} = 10\text{V}$; $I_{OLS} = 0.06\mu\text{A}$
V_{OHS}	Output High Voltage Segments	14.9 9.9			V V	$V_{DD} = 15\text{V}$; $I_{OHS} = -0.1\mu\text{A}$ $V_{DD} = 10\text{V}$; $I_{OHS} = -0.06\mu\text{A}$

D.C. and Operating Characteristics for 5201-2 and 5202-2

Field Effect Display Applications ($T_A = 25^\circ\text{C}$; $6\text{V} \leq V_{DD} \leq 10\text{V}$; $f_{IN} = 64\text{Hz}$ unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$I_{DD}(\text{Avg.})$	Average Operating Current			600	nA	$V_{DD} = 10\text{V}$; $t_{pwc} = 25\mu\text{s}$; $t_f = 0.5\mu\text{s}$; $t_r = 75\mu\text{s}$; outputs open
$I_{DD}(\text{Static})$	Static Current			400	nA	$V_{DD} = 10\text{V}$; 64 Hz input open; outputs open
I_{IL}	Input Low Current	-0.5	-1.5		μA	$V_{DD} = 6.0\text{V}$; $V_{IN} = 1.2\text{V}$
V_{IL}	Input Low Voltage	-0.3		1.2	V	$V_{DD} = 10\text{V}$
V_{IH}	Input High Voltage	9.0		10.3	V	$V_{DD} = 10\text{V}$
V_{OLC}	Output Low Voltage Common			25 50	mV mV	$V_{DD} = 10\text{V}$; $I_{OLC} = 0.15\mu\text{A}$ $V_{DD} = 6\text{V}$; $I_{OLC} = 0.1\mu\text{A}$
V_{OHC}	Output High Voltage Common	9.975 5.950			V V	$V_{DD} = 10\text{V}$; $I_{OHC} = -0.15\mu\text{A}$ $V_{DD} = 6\text{V}$; $I_{OHC} = -0.1\mu\text{A}$
V_{OLS}	Output Low Voltage Segments			25 50	mV mV	$V_{DD} = 10\text{V}$; $I_{OLS} = 10\text{nA}$ $V_{DD} = 6\text{V}$; $I_{OLS} = 6\text{nA}$
V_{OHS}	Output High Voltage Segments	9.975 5.950			V V	$V_{DD} = 10\text{V}$; $I_{OHS} = -10\text{nA}$ $V_{DD} = 6\text{V}$; $I_{OHS} = -6\text{nA}$

A.C. Characteristics for 5201 and 5202 (T_A = 25°C ; f_{in} = 64Hz)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
t _{pwc}	Input Pulse Width	10	15	25	μs	V _{IL} = 1.2V
t _f	Input Pulse Fall Time			0.5	μs	V _{IL} = 1.2V; V _{IH} = 14V; V _{DD} = 15V
t _r	Input Pulse Rise Time			35	μs	V _{IL} = 1.2V; V _{IH} = 14V; V _{DD} = 15V

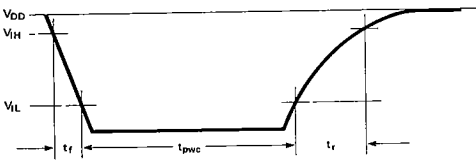
A.C. Characteristics for 5201-2 and 5202-2 (T_A = 25°C ; f_{in} = 64Hz)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
t _{pwc}	Input Pulse Width	10	15	25	μs	V _{IL} = 1.2V
t _f	Input Pulse Fall Time			0.5	μs	V _{IL} = 1.2V; V _{IH} = 14V; V _{DD} = 15V
t _r	Input Pulse Rise Time			75	μs	V _{IL} = 1.2V; V _{IH} = 9V; V _{DD} = 10V

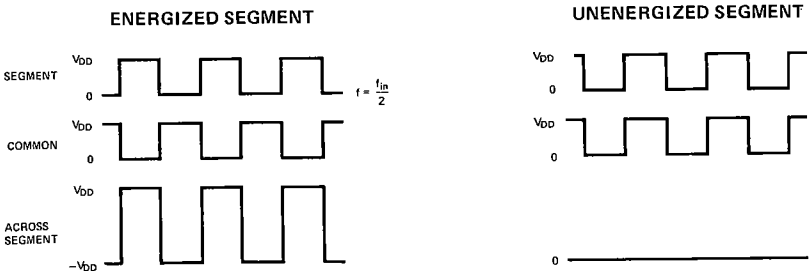
Capacitance (T_A = 25°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
C _{IN}	Input Capacitance		2.8	5	pF	Capacitances are measured in 30 lead flatpack with all pins except the test pin at ground, f = 1 MHz.
C _{OUTC}	Output Capacitance Common		8.5	15	pF	
C _{OUTS}	Output Capacitance Segments		2.0	5	pF	

Input Waveform



Output Waveforms

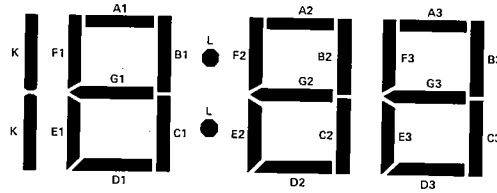


Time Setting

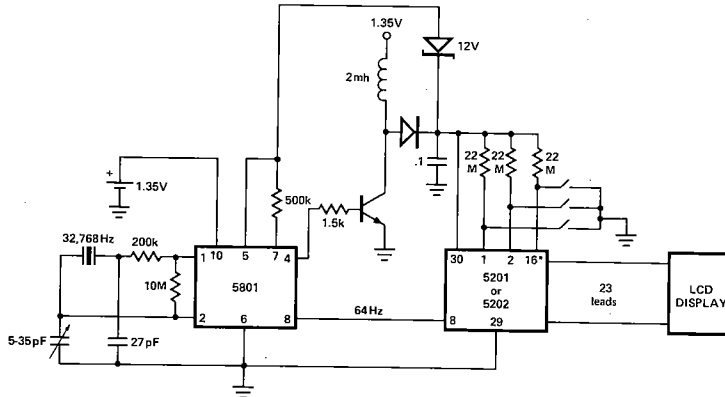
Two inputs (Reset I and Reset II) allow setting and synchronization of the time to a time standard. The operation of these two inputs is described by the following table:

State	Reset I	Reset II	Operation
B ₁	V _{DD}	V _{DD}	Normal
B ₂	V _{DD}	0	Clock Running, hours are advanced at 1Hz
B ₃	0	0	Seconds counter is reset to 00 sec.; minutes are advanced at 1Hz rate; hours are incremented by 1 if minutes exceed 59, otherwise they are unaffected.
B ₄	0	V _{DD}	Seconds counter reset to 00 sec.; minutes are held if state B ₄ is entered directly from state B ₃ ; hours are unaffected. Note: Minutes will be incremented by one if state B ₄ is entered from state B ₁ or B ₂ .

Display Segment Format

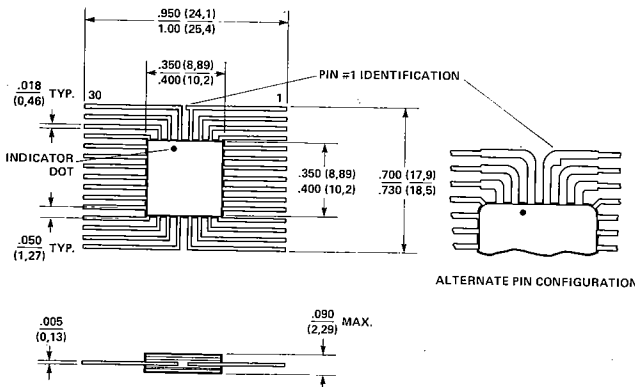


Typical Application



(*5201, 5201-2 ONLY)

Packaging Information



PIN ASSIGNMENT

Pin No.	Function	Pin No.	Function
1	Reset II	16	Seconds Switch*
2	Reset I	17	B3
3	Common	18	A3
4	K	19	F3
5	E1	20	G3
6	D1	21	B2
7	C1	22	A2 + D2
8	64Hz In	23	F2
9	L (Colon)	24	G2
10	E2	25	B1
11	C2	26	A1
12	E3	27	F1
13	D3	28	G1
14	C3	29	Ground
15	N/C	30	V _{DD}

*5201 and 5201-2 only